

In The Claims:

Claims 1-4. (Cancelled)

5. (Currently Amended) ~~The system of claim 4 wherein~~ A system for efficiently performing a pattern matching procedure using an electronic apparatus, comprising:

an enrollment manager that performs an image conversion procedure for converting an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format; and

a verification manager that converts an initial test image into a transformed test image, said verification manager then combining said reference template and said transformed test image into a correlation image, said verification manager analyzing matching characteristics of said correlation image to determine whether said initial test image matches said initial reference image, said enrollment manager performing a first binarization step to create initial binarization values for said binarization procedure by substituting a decimal value of "1" for all complex coefficients from said initial reference image that are greater than or equal to zero, said enrollment manager also substituting a decimal value of "-1" for all of said complex coefficients that are less than zero, said initial binarization values then being utilized for any further calculations during said pattern matching procedure, said enrollment manager performs performing a second binarization step to create stored binarization values for said binarization procedure by substituting a binary value of "1" for all of said complex coefficients from said initial

binarization values that are equal to “-1”, and by also substituting a binary value of “0” for all of said complex coefficients from said initial binarization values that are equal to “1”, said complex coefficients thus each being expressed with a single binary bit, said stored binarization values subsequently being converted into said initial binarization values for performing any required mathematical calculations.

Claim 6. (Cancelled)

7. (Currently Amended) ~~The system of claim 1 wherein~~ A system for efficiently performing a pattern matching procedure using an electronic apparatus, comprising:

an enrollment manager that performs an image conversion procedure for converting an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format; and

a verification manager that converts an initial test image into a transformed test image, said verification manager then combining said reference template and said transformed test image into a correlation image, said verification manager analyzing matching characteristics of said correlation image to determine whether said initial test image matches said initial reference image, said verification manager creates creating said correlation image by performing a multiplication procedure that multiplies corresponding pixel values from said reference template and said transformed test image to produce correlation pixel values for said correlation image, said correlation pixel values being obtained from a multiplication

lookup table to conserve system resources such as processing requirements and memory requirements.

8. (Original) The system of claim 7 wherein said multiplication lookup table is implemented with initial binarization values from said binarization procedure, each complex value from said reference template and said transformed test image being expressed with one of only four complex numbers, said four complex numbers being " $1 + j$ ", " $1 - j$ ", " $-1 + j$ ", and " $-1 - j$ ", said multiplication lookup table including a vertical reference-pixel index column having a first reference pixel value ($1 + j$), a second reference pixel value ($1 - j$), a third reference pixel value ($-1 + j$), and a fourth reference pixel value ($-1 - j$), said multiplication lookup table also including a horizontal test-pixel index row having a first test pixel value ($1 + j$), a second test pixel value ($1 - j$), a third test pixel value ($-1 + j$), and a fourth test pixel value ($-1 - j$).

Claims 9-10. (Cancelled)

11. (Currently Amended) ~~The system of claim 1 wherein~~ A system for efficiently performing a pattern matching procedure using an electronic apparatus, comprising:

an enrollment manager that performs an image conversion procedure for converting an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format; and

a verification manager that converts an initial test image into a transformed test image, said verification manager then combining said reference template and said transformed test image into a correlation image, said verification manager analyzing matching characteristics of said correlation image to determine whether said initial test image matches

said initial reference image, said enrollment manager ~~performs~~ performing a discrete symmetrical reduction procedure upon said binarized reference image to produce a reduced reference image which said enrollment manager stores as said reference template.

Claims 12-14. (Cancelled)

15. (Currently Amended) ~~The system of claim 14 wherein~~ A system for efficiently performing a pattern matching procedure using an electronic apparatus, comprising:

an enrollment manager that performs an image conversion procedure for converting an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format; and

a verification manager that converts an initial test image into a transformed test image, said verification manager then combining said reference template and said transformed test image into a correlation image, said verification manager analyzing matching characteristics of said correlation image to determine whether said initial test image matches said initial reference image, said verification manager converting said initial test image into an FFT test image by performing a single Fast Fourier Transform procedure upon said initial test image, said verification manager performing a two-step binarization procedure upon said FFT test image to produce a binarized test image that is stored with a single binary bit representing each complex pixel value coefficient, said verification manager performing a symmetrical reduction procedure upon said FFT test image to produce and store a reduced test image, said verification manager ~~performs~~ performing a complex conjugation procedure upon said reference template to produce a conjugated

reference image, said complex conjugation procedure converting each pixel value from said reference template into a corresponding complex conjugate value by inverting an arithmetic operation that connects real and imaginary portions of complex values for said each pixel value from said reference template.

16. (Original) The system of claim 15 wherein said verification manager performs a multiplication procedure with said conjugated reference image and said reduced test image to produce a reduced correlation image.

17. (Original) The system of claim 16 wherein said verification manager performs said multiplication procedure by referencing a multiplication lookup table to index pixel values from said conjugated reference image and said reduced test image to produce corresponding correlation pixel values for said reduced correlation image.

18. (Original) The system of claim 16 wherein said verification manager performs a symmetrical regeneration procedure upon said reduced correlation image to produce a full FFT correlation image.

19. (Original) The system of claim 18 wherein said verification manager performs an inverse FFT procedure upon said full FFT correlation image to generate a complex correlation image, said verification manager discarding imaginary values from each pixel value of said complex correlation image to produce a real correlation image, said verification manager then performing an FFT shift procedure to generate a correlation graph that represents pixels from said real correlation image.

20. (Original) The system of claim 19 wherein said verification manager computes a peak side-lobe ratio from said correlation graph for comparing with a pre-determined correlation threshold to determine whether said initial test image matches said initial reference image, said peak side-lobe ratio being expressed by a formula:

$$PSR = (Peak\ Value - Mean\ Value) / STD$$

where said PSR is said peak side-lobe ratio, said Peak Value is a correlation image pixel with a greatest magnitude, said Mean Value is an arithmetical mean value of correlation image pixels in a pre-defined side-lobe area surrounding said Peak Value, and said STD is a standard deviation of said correlation image pixels in said pre-defined side-lobe area.

Claims 21-24. (Cancelled)

25. (Currently Amended) ~~The method of claim 24 wherein~~ A method for efficiently performing a pattern matching procedure, comprising:

performing an image conversion procedure with an enrollment manager to convert an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format;

converting an initial test image into a transformed test image with a verification manager;

combining said reference template and said transformed test image into a correlation image with said verification manager; and

analyzing matching characteristics of said correlation image with said verification manager to determine whether said initial test image matches said initial reference image, said enrollment manager

performing a first binarization step to create initial binarization values for said binarization procedure by substituting a decimal value of “1” for all complex coefficients from said initial reference image that are greater than or equal to zero, said enrollment manager also substituting a decimal value of “-1” for all of said complex coefficients that are less than zero, said initial binarization values then being utilized for any further calculations during said pattern matching procedure, said enrollment manager performs performing a second binarization step to create stored binarization values for said binarization procedure by substituting a binary value of “1” for all of said complex coefficients from said initial binarization values that are equal to “-1”, and by also substituting a binary value of “0” for all of said complex coefficients from said initial binarization values that are equal to “1”, said complex coefficients thus each being expressed with a single binary bit, said stored binarization values subsequently being converted into said initial binarization values for performing any required mathematical calculations.

Claim 26. (Cancelled)

27. (Currently Amended) ~~The method of claim 21 wherein~~ A method for efficiently performing a pattern matching procedure, comprising:

performing an image conversion procedure with an enrollment manager to convert an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format;
converting an initial test image into a transformed test image with a verification manager;

combining said reference template and said transformed test image into a correlation image with said verification manager; and
analyzing matching characteristics of said correlation image with said verification manager to determine whether said initial test image matches said initial reference image, said verification manager creates creating said correlation image by performing a multiplication procedure that multiplies corresponding pixel values from said reference template and said transformed test image to produce correlation pixel values for said correlation image, said correlation pixel values being obtained from a multiplication lookup table to conserve system resources such as processing requirements and memory requirements.

28. (Original) The method of claim 27 wherein said multiplication lookup table is implemented with initial binarization values from said binarization procedure, each complex value from said reference template and said transformed test image being expressed with one of only four complex numbers, said four complex numbers being " $1 + j$ ", " $1 - j$ ", " $-1 + j$ ", and " $-1 - j$ ", said multiplication lookup table including a vertical reference-pixel index column having a first reference pixel value ($1 + j$), a second reference pixel value ($1 - j$), a third reference pixel value ($-1 + j$), and a fourth reference pixel value ($-1 - j$), said multiplication lookup table also including a horizontal test-pixel index row having a first test pixel value ($1 + j$), a second test pixel value ($1 - j$), a third test pixel value ($-1 + j$), and a fourth test pixel value ($-1 - j$).

Claims 29-30. (Cancelled)

31. (Currently Amended) ~~The method of claim 21 wherein~~ A method for efficiently performing a pattern matching procedure, comprising:
performing an image conversion procedure with an enrollment manager to
convert an initial reference image into a reference template, said

image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format;
converting an initial test image into a transformed test image with a verification manager;
combining said reference template and said transformed test image into a correlation image with said verification manager; and
analyzing matching characteristics of said correlation image with said verification manager to determine whether said initial test image matches said initial reference image, said enrollment manager performs performing a discrete symmetrical reduction procedure upon said binarized reference image to produce a reduced reference image which said enrollment manager stores as said reference template.

Claims 32-34. (Cancelled)

35. (Currently Amended) ~~The method of claim 34 wherein~~ A method for efficiently performing a pattern matching procedure, comprising:

performing an image conversion procedure with an enrollment manager to convert an initial reference image into a reference template, said image conversion procedure including a binarization procedure and a symmetrical reduction procedure, said binarization procedure converting a non-binary complex number format into a binary number format;
converting an initial test image into a transformed test image with a verification manager;
combining said reference template and said transformed test image into a correlation image with said verification manager; and
analyzing matching characteristics of said correlation image with said verification manager to determine whether said initial test image

matches said initial reference image, said verification manager
converting said initial test image into an FFT test image by performing a
single Fast Fourier Transform procedure upon said initial test image,
said verification manager performing a two-step binarization procedure
upon said FFT test image to produce a binarized test image that is
stored with a single binary bit representing each complex pixel value
coefficient, said verification manager performing a symmetrical
reduction procedure upon said FFT test image to produce and store a
reduced test image, said verification manager ~~performs~~ performing a
complex conjugation procedure upon said reference template to produce
a conjugated reference image, said complex conjugation procedure
converting each pixel value from said reference template into a
corresponding complex conjugate value by inverting an arithmetic
operation that connects real and imaginary portions of complex values
for said each pixel value from said reference template.

36. (Original) The method of claim 35 wherein said verification manager performs a multiplication procedure with said conjugated reference image and said reduced test image to produce a reduced correlation image.

37. (Original) The method of claim 36 wherein said verification manager performs said multiplication procedure by referencing a multiplication lookup table to index pixel values from said conjugated reference image and said reduced test image to produce corresponding correlation pixel values for said reduced correlation image.

38. (Original) The method of claim 36 wherein said verification manager performs a symmetrical regeneration procedure upon said reduced correlation image to produce a full FFT correlation image.

39. (Original) The method of claim 38 wherein said verification manager performs an inverse FFT procedure upon said full FFT correlation image to generate a complex correlation image, said verification manager discarding imaginary values from each pixel value of said complex correlation image to produce a real correlation image, said verification manager then performing an FFT shift procedure to generate a correlation graph that represents pixels from said real correlation image.

40. (Original) The method of claim 39 wherein said verification manager computes a peak side-lobe ratio from said correlation graph for comparing with a pre-determined correlation threshold to determine whether said initial test image matches said initial reference image, said peak side-lobe ratio being expressed by a formula:

$$\text{PSR} = (\text{Peak Value} - \text{Mean Value}) / \text{STD}$$

where said PSR is said peak side-lobe ratio, said Peak Value is a correlation image pixel with a greatest magnitude, said Mean Value is an arithmetical mean value of correlation image pixels in a pre-defined side-lobe area surrounding said Peak Value, and said STD is a standard deviation of said correlation image pixels in said pre-defined side-lobe area.

Claims 41-44. (Cancelled)